

## **CLAIMS:**

What is claimed is:

1. A method for enhancing dynamic range of data read from an imaging sensor, said imaging sensor comprising N linear pixel arrays, each of the N linear arrays having M charge coupled pixels, each pixel charge coupled, and further being coupled to one of N registers, the method comprising:
  5. integrating charge in at least some pixels of the N linear pixel arrays;
  6. combining charge from a first region of the N linear pixel arrays of the imaging sensor in the N registers by shifting charge from the first region along each of the N linear pixel arrays to each of the N registers, said first region of the N linear pixel arrays having at least one pixel line and said at least one pixel line of the first region is oriented in generally orthogonal direction to the N linear pixel arrays;
  11. shifting charge from the N registers along a linear path;
  12. representing charge from at least a portion of the first region of the N linear pixel arrays, shifted out of the N registers, as a corresponding portion of N first region data signals;
  15. combining charge from a second region of the N linear pixel arrays in the N registers by shifting charge from said at least one pixel line of the second region along each of the N linear pixel arrays to each of the N registers, said second region having at least one pixel line, and said at least one pixel line of the second region is oriented in generally orthogonal direction to the N linear pixel arrays;
  20. shifting charge from the N registers along a linear path; and
  21. representing charge from at least a portion of the second region of the N linear pixel arrays, shifted out of the N registers, as a corresponding portion of N second region data signals.

1       2.     The method for increasing dynamic range recited in claim 1 above further  
2     comprises:

3              presenting said portion of N first region data signals; and

4              presenting said portion of N second region data signals.

1       3.     The method for increasing dynamic range recited in claim 2 above, wherein said  
2     first portion comprises N first region data signals and said second portion comprises N  
3     second region data signals.

1       4.     The method for increasing dynamic range recited in claim 1 above further  
2     comprises:

3              defining the first region of the N linear pixel arrays of the imaging sensor by  
4     designating at least one pixel line as belonging to the first region of the N linear pixel  
5     arrays.

1       5.     The method for increasing dynamic range recited in claim 4 above, wherein  
2     defining the first region of the N linear pixel arrays of the imaging sensor by designating  
3     at least one pixel line as belonging to the first region of the N linear pixel arrays further  
4     comprises:

5              assessing a level of improvement in dynamic range in at least one signal taken  
6     from the portion of N first region data signals, and the portion of N second region data  
7     signals; and

8              determining an amount of pixel lines belonging to the first region of the N linear  
9     pixel arrays for improving the dynamic range in the at least one signal, wherein said  
10    amount of pixel lines relates to the level of improvement in dynamic range.

1       6.     The method for increasing dynamic range recited in claim 4 above, wherein  
2     defining the first region of the N linear pixel arrays of the imaging sensor by designating  
3     at least one pixel line as belonging to the first region of the N linear pixel arrays further  
4     comprises:

5              setting at least one target signal level;  
6              selecting at least one signal from one of the portion of N first region data signals  
7     and the portion of N second region data signals;  
8              comparing the selected at least one signal to the at least one target signal level;  
9     and

10             adjusting an amount of pixel lines belonging to the first region of the N linear  
11     pixel arrays, wherein said adjustment is based on the comparison of the selected at least  
12     one signal to the at least one target signal level.

1       7.     The method for increasing dynamic range recited in claim 6 above, wherein  
2     adjusting an amount of pixel lines belonging to the first region of the N linear pixel arrays  
3     further comprises altering the amount of pixel lines belonging to the first region by a  
4     predetermined proportion of the amount of pixel lines.

1       8.     The method for increasing dynamic range recited in claim 6 above, wherein  
2     adjusting an amount of pixel lines belonging to the first region of the N linear pixel arrays  
3     further comprises altering the amount of pixel lines belonging to the first region by a  
4     predetermined number of pixel lines.

1       9.     The method for increasing dynamic range recited in claim 6 above further  
2     comprises modifying an amount of pixel lines belonging to the second region based on  
3     the sum of pixel lines in the first region and second region being equivalent to an amount  
4     of pixels in any one of the N linear arrays.

1       10.     The method for increasing dynamic range recited in claim 9 above, wherein said  
2     amount of pixels in each of the N linear arrays is M pixels.

1       11.     The method for increasing dynamic range recited in claim 9 above further  
2     comprises:

3              integrating charge in at least some pixels of the N linear pixel arrays;  
4              combining charge from the first region of the N linear pixel arrays of the imaging  
5     sensor in the N registers by shifting charge from said adjusted amount of pixel lines of  
6     the first region along each of the N linear pixel arrays to each of the N registers;

7              shifting charge from the N registers along a linear path;

8              representing charge from at least a portion of the first region of the N linear pixel  
9     arrays, shifted out of the N registers, as a corresponding portion of N first region data  
10   signals;

11             combining charge from the second region of the N linear pixel arrays in the N  
12   registers by shifting charge from said modified amount of pixel second region along each  
13   of the N linear pixel arrays to each of the N registers; and

14             shifting charge from the N registers along a linear path; and

15             representing charge from at least a portion of the second region of the N linear  
16   pixel arrays, shifted out of the N registers, as a corresponding portion of N second region  
17   data signals.

1       12.     The method for increasing dynamic range recited in claim 6 above, wherein said  
2     adjustment based on the comparison of the selected at least one signal to the at least one  
3     target signal level relates to difference between the selected at least one signal to the at  
4     least one target signal level.

1    13.    The method for increasing dynamic range recited in claim 6 above, wherein the at  
2    least one target signal is a range of target signal levels, and said adjustment based on the  
3    comparison of the selected at least one signal to the at least one target signal level relates  
4    to a difference between the selected at least one signal to the range of target signal levels.

1    14.    The method for increasing dynamic range recited in claim 4 above, wherein  
2    defining the first region of the N linear pixel arrays of the imaging sensor is  
3    accomplished during a setup phase of a device incorporating said imaging sensor.

1    15.    The method for increasing dynamic range recited in claim 4 above, wherein  
2    defining the first region of the N linear pixel arrays of the imaging sensor is  
3    accomplished dynamically, following said integrating charge in at least some pixels of  
4    the N linear pixel arrays, and prior to a subsequent integration of charge in at least some  
5    pixels of the N linear pixel arrays.

1    16.    The method for increasing dynamic range recited in claim 1 above further  
2    comprises:

3                presenting said portion of N first region data signals as a first channel of small-  
4    amplitude signals; and

5                presenting said portion of N second region data signals as a second channel of  
6    large-amplitude signals.

1    17.    The method for increasing dynamic range recited in claim 16 above further  
2    comprises:

3                re-scaling one of said small-amplitude signals from said first region and said  
4    large-amplitude signals from said second region.

1    18.    The method for increasing dynamic range recited in claim 17 above, wherein re-  
2    scaling one of said small-amplitude signals from said first region and said large-

3      amplitude signals from said second region is based on a scale of the other of said small-  
4      amplitude signals from said first region and said large-amplitude signals from said second  
5      region.

1      19.     The method for increasing dynamic range recited in claim 16 above further  
2      comprises:

3                determining a relationship between said small-amplitude signals of said first  
4      channel from said first region, and said large-amplitude signals of said second channel  
5      from said second region.

1      20.     The method for increasing dynamic range recited in claim 19 above further  
2      comprises:

3                applying said relationship to the corresponding at least one data signal from the N  
4      data signals representing charge from the first region of the N linear pixel arrays; and

5                replacing said at least one of the N data signals representing a saturated condition  
6      from the second region of the N linear pixel arrays.

1      21.     The method for increasing dynamic range recited in claim 20 above, wherein each  
2      of said N linear pixel arrays corresponds to a wavelength channel of an N wavelength  
3      channel spectrum and each of said N data signals representing an amplitude of said N  
4      wavelength channels of the spectrum.

1    22.    The method for increasing dynamic range recited in claim 21 above further  
2    comprises:

3                presenting as a wide dynamic-range spectrum, the data signals from the second  
4    channel of large-amplitude signals representing charge from said second region, and, the  
5    corresponding at least one data signal from the N data signals representing charge from  
6    the first region of the N linear pixel arrays replacing said at least one of the N data signals  
7    representing a saturated condition from the second region of the N linear pixel arrays.

1    23.    The method for increasing dynamic range recited in claim 1 above, wherein a  
2    corresponding each of said portion of N first region data signals and each of said portion  
3    of N second region data signals both correspond to at least one discrete wavelength.

1    24.    The method for increasing dynamic range recited in claim 1 above further  
2    comprises:

3                combining a part of said portion of N first region data signals with a non-  
4    corresponding part of said portion of N second region data signals; and

5                presenting the part of said portion of N first region data signals and the non-  
6    corresponding part of said portion of N second region data signals as a plurality of data  
7    signals.

1    25. An imaging apparatus having enhancing dynamic range comprising:

2                an imaging sensor comprising:

3                        N linear arrays, each of the N linear arrays having M charge coupled

4                        pixels;

5                        M pixel lines, said M pixel lines being oriented in generally orthogonal

6                        direction to the N linear pixel arrays;

7                        N registers, wherein one pixel in each of the N linear pixel arrays being

8                        charge coupled to a respective one of the N registers;

9                        signal converter connected to at least one of said N registers for

10                      representing a charge as a data signal; and

11                      an output node coupled to said signal converter;

12                      a memory connected to said output node;

13                      a readout controller coupled to said imaging sensor for controlling readout of said

14                      M charge coupled pixels in all the N linear pixel arrays; and

15                      means for instructing said readout controller for combining charge from a first

16                      region of the N linear pixel arrays of the imaging sensor in the N registers by shifting

17                      charge from the first region along each of the N linear pixel arrays to each of the N

18                      registers, said first region of the N linear pixel arrays having at least one pixel line, and

19                      for shifting charge from the N registers along a linear path to said signal converter, and

20                      for transferring said N first region data signals to said memory, and further for instructing

21                      said readout controller for combining charge from a second region of the N linear pixel

22                      arrays of the imaging sensor in the N registers by shifting charge along each of the N

23                      linear pixel arrays to each of the N registers and for shifting charge from the N registers

24                      along a linear path to said signal converter, and for transferring said N second region data

25                      signals to said memory.

1    26.    The imaging apparatus recited in claim 25 above, wherein said memory being  
2    coupled to a display device.

1    27.    The imaging apparatus recited in claim 25 above, wherein said means for  
2    instructing alters an amount of pixel lines in a region prior to instructing said readout  
3    controller.

1        28. A computer program product, comprising a computer-readable medium having  
2        stored thereon computer executable instructions for implementing a method for  
3        enhancing dynamic range of data read from an imaging sensor having a controller that  
4        executes a plurality of reordered commands, said computer executable instructions  
5        comprising:

6                instructions for integrating charge in at least some pixels of the N linear pixel  
7        arrays;

8                instructions for combining charge from a first region of the N linear pixel arrays  
9        of the imaging sensor in the N registers by shifting charge from the first region along  
10      each of the N linear pixel arrays to each of the N registers, said first region of the N linear  
11      pixel arrays having at least one pixel line and said at least one pixel line of the first region  
12      is oriented in generally orthogonal direction to the N linear pixel arrays;

13                instructions for shifting charge from the N registers along a linear path;

14                instructions for representing charge from at least a portion of the first region of  
15      the N linear pixel arrays, shifted out of the N registers, as a corresponding portion of N  
16      first region data signals;

17                instructions for combining charge from a second region of the N linear pixel  
18      arrays in the N registers by shifting charge from said at least one pixel line of the second  
19      region along each of the N linear pixel arrays to each of the N registers, said second  
20      region having at least one pixel line, and said at least one pixel line of the second region  
21      is oriented in generally orthogonal direction to the N linear pixel arrays; and

22                instructions for shifting charge from the N registers along a linear path; and

23                instructions for representing charge from at least a portion of the second region of  
24      the N linear pixel arrays, shifted out of the N registers, as a corresponding portion of N  
25      second region data signals.

- 1 29. The computer program product recited in claim 28 above further comprises:
- 2       instructions for defining the first region of the N linear pixel arrays of the imaging
- 3 sensor by designating at least one pixel line as belonging to the first region of the N linear
- 4 pixel arrays.
- 1 30. The computer program product recited in claim 29 above further comprises:
- 2       instructions for assessing a level of improvement in dynamic range in at least one
- 3 signal taken from the portion of N first region data signals, and the portion of N second
- 4 region data signals; and
- 5       instructions for determining an amount of pixel lines belonging to the first region
- 6 of the N linear pixel arrays for improving the dynamic range in the at least one signal,
- 7 wherein said amount of pixel lines relates to the level of improvement in dynamic range.
- 1 31. The computer program product recited in claim 29 above further comprises:
- 2       instructions for setting at least one target signal level;
- 3       instructions for selecting at least one signal from one of the portion of N first
- 4 region data signals and the portion of N second region data signals;
- 5       instructions for comparing the selected at least one signal to the at least one target
- 6 signal level; and
- 7       instructions for adjusting an amount of pixel lines belonging to the first region of
- 8 the N linear pixel arrays, wherein said adjustment is based on the comparison of the
- 9 selected at least one signal to the at least one target signal level.
- 1 32. The computer program product recited in claim 31 above further comprises:
- 2       instructions for altering the amount of pixel lines belonging to the first region by a
- 3 predetermined proportion of the amount of pixel lines.

1       33. A method for reading data from an imaging sensor, said imaging sensor  
2 comprising N linear pixel arrays, each of the N linear arrays having M charge coupled  
3 pixels, each pixel charge coupled, and further being coupled to one of N registers, the  
4 method comprising:

5             defining a first region of the N linear pixel arrays of the imaging sensor, said first  
6 region having at least one pixel line and said at least one pixel line is oriented in  
7 generally orthogonal direction to the N linear pixel arrays;

8             defining a second region of the N linear pixel arrays of the imaging sensor, said  
9 second region having at least one pixel line and said at least one pixel line is oriented in  
10 generally orthogonal direction to the N linear pixel arrays;

11             defining a dark region of the N linear pixel arrays of the imaging sensor, said dark  
12 region having a plurality of pixel lines, said plurality of pixel lines are oriented in  
13 generally orthogonal direction to the N linear pixel arrays and said plurality of pixel lines  
14 are not exposed to light;

15             receiving a first image on at least some pixels of the first region of the N linear  
16 pixel arrays;

17             receiving a second image on at least some pixels of the second region of the N  
18 linear pixel arrays;

19             integrating charge in the at least some pixels of the first region of the N linear  
20 pixel arrays and in the at least some pixels of the second region of the N linear pixel  
21 arrays;

22             shifting charge from the at least some pixels of the first region and second region  
23 of the N linear pixel arrays along a linear path into said dark region of the N linear pixel  
24 arrays of the imaging sensor; and

25 reading out charge from said dark region, said charge from said dark region  
26 having been shifted from each region defined on the N linear pixel arrays of the imaging  
27 sensor.

1 34. The method for reading data recited in claim 33 above, wherein, for each region,  
2 reading out charge from said dark region further comprises:

3 combining charge integrated in a region of the N linear pixel arrays of the  
4 imaging sensor in the N registers by shifting charge from the dark region along each of  
5 the N linear pixel arrays to each of the N registers;

6 shifting charge from the N registers along a linear path; and

7 representing charge from at least a portion of the region of the N linear pixel  
8 arrays, shifted out of the N registers, as a corresponding portion of N data signals  
9 associated with the region.

1 35. The method for reading data recited in claim 34 above further comprises:

2 shifting charge from the dark region of the N linear pixel arrays of the imaging  
3 sensor in the N registers; and

4 discarding the charge shifted from the dark region of the N linear pixel arrays of  
5 the imaging sensor.

1 36. The method for reading data recited in claim 34 above, wherein the first region is  
2 further defined as a third region and a fourth region of the N linear pixel arrays of the  
3 imaging sensor.

1 37. The method for reading data recited in claim 36 above further comprises:

2 presenting said corresponding portion of N first region data signals; and

3 presenting said corresponding portion of N second region data signals.

1    38.   The method for reading data recited in claim 37 above, wherein presenting said  
2    portion of N first region data signals further comprises:

3                presenting said corresponding portion of N third region data signals; and

4                presenting said corresponding portion of N fourth region data signals.

1    39.   The method for reading data recited in claim 33, wherein a sum of the pixel lines  
2    defined in said first region, said second region and said dark region comprises at least M  
3    pixel lines.

1    40.   The method for reading data recited in claim 39, wherein said plurality of pixel  
2    lines of the dark region of the N linear pixel arrays is defined as at least  $M/2$  pixel lines.

1    41.    A method for reading data from an imaging sensor, said imaging sensor  
2    comprising N linear pixel arrays, each of the N linear arrays having M charge coupled  
3    pixels, each pixel charge coupled, and further being coupled to one of N registers, the  
4    method comprising:

5                integrating charge in at least some pixels of a first region of the N linear pixel  
6    arrays and at least some pixels of a second region of the N linear pixel arrays, said first  
7    region of the N linear pixel arrays having at least one pixel line and said at least one pixel  
8    line of the first region is oriented in generally orthogonal direction to the N linear pixel  
9    arrays, said second region of the N linear pixel arrays having at least one pixel line and  
10   said at least one pixel line of the second region is oriented in generally orthogonal  
11   direction to the N linear pixel arrays;

12               shifting charge from the at least some pixels of the first and second regions of the  
13   N linear pixel arrays along a linear path into a dark region of the N linear pixel arrays of  
14   the imaging sensor, said dark region of the N linear pixel arrays having at least two pixel  
15   lines, said at least two pixel lines of the dark region are oriented in generally orthogonal  
16   direction to the N linear pixel arrays and are not exposed to light;

17               combining charge integrated in the first region of the N linear pixel arrays of the  
18   imaging sensor in the N registers by shifting charge from the dark region along each of  
19   the N linear pixel arrays to each of the N registers;

20               shifting charge from the N registers along a linear path;

21               representing charge from at least a portion of the first region of the N linear pixel  
22   arrays, shifted out of the N registers, as a corresponding portion of N first region data  
23   signals;

24               combining charge integrated in the second region of the N linear pixel arrays of  
25   the imaging sensor in the N registers by shifting charge from the dark region along each  
26   of the N linear pixel arrays to each of the N registers;

27 shifting charge from the N registers along a linear path;  
28 representing charge from at least a portion of the second region of the N linear  
29 pixel arrays, shifted out of the N registers, as a corresponding portion of N second region  
30 data signals; and  
31 clearing charge from the dark region of the N linear pixel arrays of the imaging  
32 sensor.

1 42. The method for reading data recited in claim 41 above further comprises:  
2 presenting said portion of N first region data signals; and  
3 presenting said portion of N second region data signals.

1 43. The method for reading data recited in claim 42 above, wherein said first portion  
2 comprises N first region data signals and said second portion comprises N second region  
3 data signals.

1 44. The method for increasing dynamic range recited in claim 41 above, wherein  
2 integrating charge in at least some pixels of a first region of the N linear pixel arrays and  
3 at least some pixels of a second region of the N linear pixel arrays, further comprises:  
4 accumulating charge in the at least some pixels of the first and second regions of  
5 the N linear pixel arrays for a predetermined time period.

1 45. The method for reading data recited in claim 41 above, wherein clearing charge  
2 from the dark region of the N linear pixel arrays further comprises:

3 shifting charge from the dark region of the N linear pixel arrays of the imaging  
4 sensor in the N registers; and  
5 discarding the charge shifted from the dark region of the N linear pixel arrays of  
6 the imaging sensor.

1    46.    The method for reading data recited in claim 41, wherein the dark region of the N  
2    linear pixel arrays comprises a quantity of pixel lines at least as great as a sum of said at  
3    least one pixel line of the first region and said at least one pixel line of the second region.

1    47.    The method for reading data recited in claim 41, wherein the dark region of the N  
2    linear pixel arrays comprises at least  $M/2$  pixel lines.

1    48.    The method for reading data recited in claim 41, wherein said first region of the N  
2    linear pixel arrays having a first image projected thereon, and said second region of the  
3    N linear pixel arrays having a second image projected thereon.

1    49.    The method for reading data recited in claim 41, wherein said first region of the N  
2    linear pixel arrays being exposed to a first light source, and said second region of the N  
3    linear pixel arrays being exposed to a second light source.

- 1        50.     The method for reading data recited in claim 41 above further comprises:
- 2                integrating charge in at least some pixels of at least one other region of the N  
3        linear pixel arrays, each of said at least one other region of the N linear pixel arrays  
4        having at least one pixel line and said at least one pixel line of said at least one other  
5        region of the N linear pixel arrays is oriented in generally orthogonal direction to the N  
6        linear pixel arrays;
- 7                shifting charge from the at least some pixels of said at least one other region of  
8        the N linear pixel arrays along a linear path into a dark region of the N linear pixel arrays  
9        of the imaging sensor;
- 10               for each of the at least one other region of the N linear pixel arrays, combining  
11        charge integrated in one of the at least one other region of the N linear pixel arrays by  
12        shifting charge from the dark region along each of the N linear pixel arrays to each of the  
13        N registers; and
- 14               shifting charge from the N registers along a linear path.